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ABSTRACT

Classroom behaviors from the Texas Junior High School Study were related to achievement using both class means and student scores within classes as the units of analysis. Behaviors significantly related to achievement at the class level of analysis were not related to achievement within the class and vice versa. There was no clear pattern of significant relationships at the class level of analysis. However, significant within-class relationships did form a pattern indicating that students who were not as successful academically as other students in the class with similar entering ability, tended to act differently in the classroom and were treated differently by the teacher. Several explanations were offered for this pattern of teacher-student interactions occurring within classes. It was concluded that results obtained at one level of analysis cannot be generalized to other levels. Therefore, it is important that multilevel classroom data be analyzed at both the class and student within class levels to develop a more thorough understanding of the relation of classroom processes to student achievement. (Author)

Multilevel Analyses of Teacher-student Relationships in Junior High Classrooms

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Abstract

Classroom behaviors from the Texas Junior High School Study were related to achievement using both class means and student scores within classes as the units of analysis. Behaviors significantly related to achievement at the class level of analysis were not related to achievement within the class and vice versa. There was no clear pattern of significant relationships at the class level of analysis. However, significant within-class relationships did form a pattern indicating that students who were not as successful academically as other students in the class with similar entering ability, tended to act differently in the classroom and were treated differently by the teacher. Several explanations were offered for this pattern of teacher-student interactions occurring within classes. It was concluded that results obtained at one level of analysis cannot be generalized to other levels. Therefore, it is important that multilevel classroom data be analyzed at both the class and student within class levels to develop a more thorough understanding of the relation of classroom processes to student achievement.

Multilevel Analyses of Teacher-student Relationships in Junior High Classrooms

Determining the effects of educational processes on student learning has been a major focus of educational research during the past decade. Much of this research has involved relating teacher behaviors that occur naturally in the classroom to student achievement in an attempt to find behaviors that are effective in promoting student learning (Anderson, Evertson, & Brophy, 1979; Evertson, Anderson, Anderson, & Brophy, 1980; Stallings, 1975; Good & Grouws, Note 1). One of the more serious problems that has been encountered in this research concerns the inherent multilevel nature of educational data. That is, student learning occurs in the context of a classroom and not as an isolated event. Accordingly, class means have most frequently been used as the units of analysis, even when the data have been collected on individual students. Recently, however, Cronbach (Note 2), Burstein (Note 3), and others have argued that relationships occurring at the class level of analysis may not coincide with those occurring at the student level within classes. Discrepancies between relationships at the two levels would be expected for several reasons.

First, an average class behavior may represent a different construct from an individual level behavior. For example, the average proportion of correct answers for a particular classroom provides information about the teacher's policies with regard to task difficulty. That is, between-class differences on this variable are related, at least partially, to differences in the difficulty level of the materials teachers assign to students in their classes, rather than to overall differences between classes in student ability. However, at the student

level, the number of questions a student answers correctly also reveals something about the ability level of the student. Therefore, the meaning of the behaviors being studied may vary depending upon the unit of analysis.

Second, student-within-class analyses involve a comparison of relative differences occurring within the classroom on the behaviors of interest, with mean differences between classes removed. Therefore, a different type of question is addressed by within-class analyses than that addressed by class level analyses. Again, this concept is probably best illustrated with an example. It is possible to find no relationship between a behavior such as criticism and achievement at the class level but a strong relationship within the class. Such results would suggest that although the absolute amount of criticism a class receives is not important, the way that criticism is allocated within the class is important. In other words, the achievement of students in a class who receive more criticism relative to other students in the same class may be affected simply because these student know that they received a greater amount than other class members.

Other researchers have shown that the consideration of within-class or within-group analyses along with class level analyses can be important in developing an understanding of the relationship between classroom behaviors and student achievement. Martin, Veldman, and Anderson (1980) investigated the relationship of certain classroom behaviors to achievement using several different levels of analysis. Their data were collected on teacher-student interactions that occurred while first-grade students participated in reading groups within intact

classrooms. Thus, they were able to analyze their data at three levels: class, reading-group-within-class, and student-within-reading- group. They found many more significant relationships at the student level within reading groups than at the other levels, and attributed this primarily to the students' awareness of their standing within the group.

The purpose of the study reported here was to investigate both class level and within-class level relationships between classroom behaviors and student achievement in seventh- and eighth-grade math and English classes. It was expected that within-class analyses would provide additional information about relationships obtained between classroom behaviors and student achievement.

Methodology

Overview

Data for this investigation came from the Texas Junior High School Study, a large multifaceted study designed to identify variables that were related to affective and cognitive student outcomes in seventh- and eighth-grade math and English classes. During the 1974-1975 school year, 58 math and 78 English classes were visited alternately by two observers approximately 20 times. In each class, 10 to 12 students were chosen randomly, within sex, for intensive observation and these students' interactions with the teacher were recorded on a low inference observational coding system.

The California Achievement Test (CAT) was given at the beginning of the school year and was used as the pretest measure. The posttests, given at the end of the school year, were specially designed achievement tests in both math and English.

Other data were also collected but will not be discussed here. The methodology and results of this large study are completely described in Evertson et al. (1980).

Subjects

A total of 68 teachers were observed in nine junior high schools that represented a wide range of socio-economic status levels in a large urban school district. Because two sections were observed for each teacher, there were 136 classes in all, 58 math and 78 English. Teachers selected for the study had at least one year of previous experience teaching in their subject matter area.

The data set for the analyses presented in this paper differs in several ways from the original data set described above. First, all students without both pre- and posttest scores were eliminated. Second, math classes containing fewer than six students and English classes containing fewer than seven students were dropped. Finally, two math and three English classes were dropped because their scores were so radically different from other classes that they seriously affected the distribution and were considered outliers, i.e., atypical of math and English junior high classes included in this sample.

The original sample consisted of 58 math classes with a total of 705 students and 78 English classes with a total of 951 students. The final data set consisted of 50 math and 55 English classes. Data were available for a total of 397 students in math classes and 456 students in English classes with an average of eight students per class for both math and English.

Data Collection

Two observers were trained to use the observational coding system. The observers were trained to a reliability criterion of 80% agreement on each major section of the coding system. Thereafter, observers worked alone. Observers alternated visits to classrooms so that each class was observed approximately 20 times throughout the school year.

Independent Variables

The variables reported here were chosen because they represented the four major components of an academic interaction between the teacher and an individual student: selection of the student, questioning by the teacher, the students' answer, and the teacher's response to the answer. Student misbehaviors, both disruptive and nondisruptive, were also included.

Proportion variables were created from several categories of the observation system. Frequencies of single categories (e.g., the number of correct answers) were summed across all observations for the two units of analysis (teachers and students). Then, these frequencies were used to create proportions representing actual occurrences compared to maximum possible occurrences (e.g., the proportion of all answers that were correct answers). These proportion variables are listed in Tables 1 and 2.

Data Analyses

Two sets of regression models were evaluated for each independent variable: one that used class means as the unit of analysis and one that analyzed student scores within classes. In both sets of regression models, CAT scores were used as a covariable and achievement scores were used as the criterion. Data were analyzed separately for English and

for math. At each of the two levels of analysis, tests were performed to detect statistical interactions (i.e., the relationships between classroom behaviors and achievement varied according to entering ability) and main effects (i.e., there was a linear relationship between classroom behaviors and achievement when entering CAT score was a covariable).

The first set of models (shown below in abbreviated notation) contained class means as the unit of analysis. Predictors were the classroom behavior variable and the interaction of the behavior variable with CAT:

$$ACHc = CATc + CBc + CATc*CBc + E$$

where ACHc is the class mean achievement score (either math or English),

CATc is the class mean on the California Achievement Test (for either math or English),

CBc is the class mean on the behavior described by that variable,

CATc*CBc is the vector registering the interaction of CAT and classroom behavior, and

Ec is the error term.

The second set of models contained student scores as the unit of analysis. Predictors were the classroom behavior variable, the interaction of the behavior variable with CAT, and a set of binary vectors indicating class membership. Inclusion of the binary vectors in the restricted models in which CATs*CBs and then CBs were omitted had the effect of analyzing student scores within classes.

$$ACHs = CATs + CBs + CATs*CBs + C1 + C2 + \ldots + CN + Es$$

where C1, C2, etc., are binary class membership vectors. Other terms

correspond to the definitions given above, except that all entries were student scores.

Results

Significant main effects and interactions obtained from the regression equations for both class level and student-within-class level analyses are presented in Table 1 for math and Table 2 for English. Table 3 compares the average standard deviation of student scores for classes with the standard deviation of class means for both English and math. Significant results from the regression analyses are summarized below.

Results from the two levels of analysis will be interpreted in different ways. When class means were the unit of analysis, relationships described ways that mean behaviors, which differed between classes, related to differences in class mean achievement. In contrast, student-within-class analyses determined whether student scores on the behaviors were related to student adjusted achievement. Because student scores were compared within classes, relationships obtained in these analyses were relative. That is, a positive relationship indicated that students receiving a higher amount of the behavior relative to other students in the same class achieved more, regardless of the actual amount of the behavior received by the students.

Results of Math Class Level Analyses

In math, four of the 24 behaviors investigated in this study were significantly related to achievement at the class level of analysis. The greater the number of call outs occurring in a class, the lower the class achievement. Within the class, however, call outs were not related to achievement. Higher ability classes achieved more and lower ability classes achieved less when correct answers were followed.

immediately by new questions from the teacher. The proportion of correct answers followed by new questions was not related to achievement within the class.

When provided with more sustained feedback, higher ability classes achieved more, but lower ability classes achieved slightly less. Sustaining feedback was not related to achievement within the class. Sustaining feedback was coded whenever the teacher tried to help a student figure out the correct answer by providing clues or repeating the question.

And finally, with more nondisruptive misbehaviors, higher ability classes achieved more and lower ability classes achieved less. Within the class, nondisruptive behaviors were not related to achievement. Nondisruptive misbehaviors were mild misbehaviors such as daydreaming, wasting time, and socializing that provoked a reaction from the teacher.

Results of Math Within-class Analyses

Only three of the 24 behaviors were significantly related to achievement within math classes. None of these three behaviors were related to achievement at the class level of analysis.

Within classes, students who failed to respond to teacher questions achieved less, students who more frequently sought out the teacher for academic help achieved more, and finally, students who either failed to respond or who said they did not know the answer to a teacher question and were criticized by the teacher, achieved less. (This relationship was more pronounced for lower achieving students.)

Results of English Class Level Analyses

At the class level of analysis in English, three of the 24 behaviors were significantly related to achievement. Lower ability classes that received more process questions achieved more while higher ability

classes achieved less. There was no relationship between process questions and achievement within the class. Process questions were questions that required students to explain how they derived their answers.

Call outs were not related to achievement for higher ability classes but were negatively related to achievement for lower ability classes. As in math classes, call outs were not related to achievement within the class.

Higher ability classes in which students failed to respond or responded with "don't know" and were given sustaining feedback achieved more, while lower ability classes achieved less. Within the class, this variable was not related to achievement.

Results of English Within-class Analyses

Six behaviors were significantly related to achievement within English classes. Within these classes, students who received more product questions achieved less. At the class level, product questions were not related to achievement. Product questions were short-answer questions that allowed the teacher to provide practice and to test student comprehension.

Within classes, students who had more teacher-initiated contacts achieved less. The number of teacher-initiated contacts was not related to achievement at the class level of analysis.

Within classes, students who received more academic contacts with process feedback achieved less, while at the class level the number of academic contacts with process feedback was not related to achievement. Process feedback involved more detailed explanations by the teacher of the step by step processes involved in attaining the correct answer.

Within classes, students who answered more questions incorrectly achieved less. The average number of incorrect answers was not related to achievement at the class level.

Within classes, higher ability students who failed to respond achieved more and lower ability students who failed to respond achieved less. For math, failures to respond were negatively related to achievement within classes regardless of ability level. At the class level, failures to respond were not related to achievement for either math or English.

Within a class, lower ability students who displayed more disruptive behaviors achieved less but the achievement of higher ability students was not affected by disruptive behaviors. At the class level, disruptive behaviors were not related to achievement. Disruptive behaviors were serious misbehaviors that disrupted the work of other students in the class.

Discussion

There were few significant relationships between behaviors and achievement at the class level of analysis and those that were significant did not seem to fit together into any particular pattern. Therefore, only behaviors significantly related to achievement in both English and math will be discussed. It should be noted that these behaviors were not related to achievement within the class indicating that these class level relationships can only be explained in terms of events affecting the class as a whole.

In math, the greater the number of call outs occurring in a class, the lower class achievement. In English, however, call outs were negatively related to achievement only for lower ability classes and

were unrelated to achievement for higher ability classes. Within classes, call outs were not related to achievement in either English or math. A negative relationship between call outs and achievement at the class level has been found by other researchers (Anderson et al., 1979). Possibly call outs, which are generally discouraged by teachers, are indicative of management problems which, in turn, have been linked to lower achievement (Emmer & Evertson, Note 4; Evertson, in press). The absence of a negative relationship for higher ability English classes is difficult to explain.

In math, the proportion of total response opportunities provided with sustaining feedback was positively related to achievement for higher ability classes but negatively related to achievement for lower ability classes. Similarly, higher ability English classes in which students failed to respond or responded with "don't know" and were given sustaining feedback achieved more while lower ability classes achieved less. Within English or math classes, sustaining feedback given to all response opportunities or to "don't know" and failures to respond was not related to achievement.

In higher ability classes, the students may have the necessary skills and motivation to figure out the answer fairly quickly when given more time or help from the teacher. In lower ability classes, however, students may remain "stuck" for some time on a single question while the teacher tries to help the student figure out the correct answer. Meanwhile, the rest of the class is left with nothing to do. Consequently, students may tend to engage in more disruptive and inappropriate behavior making it difficult for the teacher to regain the students attention when ready to move on to a new question. Also, if pacing is

disrupted by forcing the class to wait idly while the teacher interacts with a single student, less academic material will be covered.

Significant within-class relationships between behaviors and adjusted achievement did tend to form a consistent pattern; students who were not as successful academically as other students with similar entering ability in the same class tended to act differently in the classroom and were treated differently by the teacher. This within-class pattern may be attributable to several factors.

First, students who more often failed to respond to teacher questions or who answered incorrectly, achieved less. This seems reasonable as these student behaviors (incorrect answers and failures to respond) can be considered symptoms of failure and hence, would be expected to occur more frequently for poorly achieving students. However, other teacher behaviors that were significantly related to adjusted achievement within classes suggest that teachers may have attempted to modify their behavior when dealing with these poorly achieving students. Product questions, teacher academic contacts, process feedback, and teacher criticism were negatively related to adjusted achievement. Possibly, teachers directed more of these behaviors to students in their classes who were having greater learning difficulties. That is, teachers possibly directed more short answer "product" questions to students who were either not paying attention or were most in need of drill and practice. Also, teachers probably contacted students in the class who were having academic problems more frequently than other students, and when they did contact these students, they were probably more likely to provide them with process feedback (step-by step explanations for how to arrive at the correct answer). Finally, it

seems likely that teachers, when they chose to use criticism, criticized those students within their class who were not working up to their full potential.

The behaviors discussed above, both teacher and student, were not significantly related to achievement at the class level of analysis probably because class averages on the behaviors represent different constructs than do the individual level variables. Some teachers may tend to use more of these behaviors and some may use less. Consequently, average amounts of the behaviors for each class may reveal more about the teacher's general method of instruction than about the achievement of the class as a whole.

A second explanation for the pattern of significant within-class relationships involves awareness among students of their standing within the class. The effect of within-class awareness on achievement can best be illustrated by considering three of the significant within-class behaviors -- incorrect answers, failures to respond, and teacher criticism. A student's standing compared to other students within the class on these behaviors may influence the student's academic self concept, that is, the student's perception of him/herself as a good or poor student. Students within a class who most often fail to respond to teacher questions or respond incorrectly, or students who are criticized more than their peers, may perceive themselves (and be perceived by other students in the class) as the class "dummies." These students may come to believe that they have no control over their academic achievement because, regardless of how hard they try, they are always less successful than their fellow classmates. Cooper (1979), in

reviewing the expectancy literature suggested that student motivation is adversely affected by such feelings of inefficacy. Accordingly, students who are generally less successful than their peers may develop feelings of inefficacy which may lead to lessened motivation and finally, to lower achievement. In this situation then, how often a behavior occurs in a class is not so important as who, within that class, receives the behavior.

These within-class comparisons are probably less important in junior high than in elementary school (see Martin et al., 1980). On the average, students spend slightly less than an hour in any one class in junior high and therefore, a student's standing in that class is probably not as important as in elementary school when the whole day may be spent in a single class. Also, by the time students reach junior high school they have many years of classroom experience with which to judge their present performance so that a student's standing in any particular class for a single semester or year may be less important than in earlier grades. Nonetheless, within-class comparisons may still be a powerful force affecting student attitudes and subsequent achievement in junior high schools.

In summary, at the class level of analysis no clear pattern of significant relationships was found between behaviors and achievement. However, significant within-class relationships did form a pattern that indicated students who were not as sucessful academically as other students in the same class with similar entering ability tended to act differently in the classroom and were treated differently by the teacher. Possible explanations were offered for this pattern of teacher-student interactions occurring within the class.

Clearly, class level relationships between behaviors and achievement cannot be generalized to individual students within classes. Analyses at the class level address different questions than do those at the student within-class level. That is, factors influencing relationships at the class level may not operate at the student level within classes and vice versa. Therefore, when researchers are confronted with multilevel classroom data it is important that the data be analyzed at both the class and student within-class levels to develop a more thorough understanding of the relationship of classroom processes to student achievement.

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Table 1

Summary Table of Results For Math

Teacher Behavior	Class $\bar{x}$	Class SD	Class R^2 Difference for Interaction	Class R^2 Difference for Main Effect	Student Within Class $\bar{x}$	Student Within Class SD	Student Within Class R^2 Difference for Interaction	Student Within Class R^2 Difference for Main Effect
Teacher Questions:								
1. Process questions	.16	.13	.0031	.0094	.16	.13	.0000	.0001
2. Product questions	.82	.13	.0009	.0148	.82	.14	.0001	.0002
Teacher Selection of Students:								
3. Who are nonvolunteers	.49	.24	.0043	.0008	.49	.19	.0009	.0004
4. Who are volunteers	.24	.19	.0009	.0177	.24	.16	.0004	.0000
5. Student callouts in response to a teacher question	.21	.21	.0068	.0201(-)	.21	.17	.0002	.0000
Response Opportunities:								
6. With correct answers	.77	.15	.0013	.0136	.76	.16	.0004	.0004
7. With incorrect answers	.16	.14	.0019	.0047	.16	.12	.0002	.0002
8. With don't know answers	.04	.04	.0036	.0041	.04	.05	.0003	.0000
9. With no response answers	.04	.04	.0009	.0155	.04	.06	.0011	.0057(-)
Correct Answers Followed By:								
10. Praise	.12	.12	.0014	.0140	.12	.11	.0005	.0015
11. New question	.07	.08	.0242	.0110	.07	.07	.0005	.0003
Incorrect Answers Followed By:								
12. Criticism	.01	.04	.0035	.0114	.01	.03	.0000	.0023

Table 1-continued

Teacher Behavior	Class $\bar{x}$	Class SD	Class R^2 Difference for Interaction	Class R^2 Difference for Main Effect	Student Within Class $\bar{x}$	Student Within Class SD	Student Within Class R^2 Difference for Interaction	Student Within Class R^2 Difference for Main Effect
13. Process feedback	.15	.21	.0097	.0001	.15	.16	.0002	.0001
14. Sustaining feedback	.20	.19	.0012	.0106	.20	.20	.0003	.0029
Don't Know and No Response Answers Followed By:								
15. Criticism	.05	.17	.0002	.0037	.05	.03	.0104	.0002
16. Sustaining feedback	.15	.17	.0006	.0001	.15	.18	.0016	.0026
All Response Opportunities Followed By:								
17. Praise	.09	.09	.0031	.0192	.09	.08	.0008	.0010
18. Sustaining feedback	.10	.08	.0209	.0025	.10	.09	.0000	.0010
19. Process feedback	.25	.10	.0000	.0147	.25	.12	.0001	.0001
Academic Contacts:								
20. Student created	.63	.14	.0026	.0122	.62	.19	.0000	.0031(+)
21. Teacher created	.55	.20	.0002	.0007	.55	.25	.0002	.0000
22. That were private	.62	.13	.0012	.0057	.62	.16	.0000	.0023
Misbehaviors:								
23. Nondisruptive	.46	.22	.0378	.0004	.46	.27	.0003	.0001
24. Disruptive	.09	.08	.0126	.0044	.09	.11	.0009	.0004

NOTE: Probability values are indicated by underlining: $p < .05$ where one line appears; $p < .01$ where two lines appear.

Table 2

Summary Table of Results For English

Teacher Behavior	Class $\bar{x}$	Class SD	Class R^2 Difference for Interaction	Class R^2 Difference for Main Effect	Student Within Class $\bar{x}$	Student Within Class SD	Student Within Class R^2 Difference for Interaction	Student Within Class R^2 Difference for Main Effect
Teacher Questions:								
1. Process questions	.14	.14	.0114	.0000	.14	.12	.0000	.0002
2. Product questions	.79	.15	.0000	.0001	.79	.16	.0000	.0047(-)
Teacher Selection of Students:								
3. Who are nonvolunteers	.48	.23	.0008	.0028	.48	.20	.0002	.0000
4. Who are volunteers	.25	.22	.0035	.0001	.25	.16	.0001	.0002
5. Student callouts in response to a teacher question	.12	.13	.0112	.0123	.12	.13	.0009	.0012
Response Opportunities:								
6. With correct answers	.82	.11	.0030	.0013	.82	.14	.0005	.0028
7. With incorrect answers	.10	.07	.0000	.0001	.10	.10	.0003	.0052(-)
8. With don't know answers	.03	.04	.0046	.0026	.03	.05	.0002	.0001
9. With no response answers	.04	.06	.0026	.0019	.04	.07	.0037	.0000
Correct Answers Followed By:								
10. Praise	.12	.12	.0014	.0007	.12	.10	.0007	.0018
11. New question	.07	.08	.0019	.0000	.07	.07	.0006	.0010
Incorrect Answers Followed By:								
12. Criticism	.02	.07	.0034	.0010	.01	.02	.0000	.0009

Table 2-continued

Teacher Behavior	Class $\bar{x}$	Class SD	Class R^2 Difference for Interaction	Class R^2 Difference for Main Effect	Student Within Class $\bar{x}$	Student Within Class SD	Student Within Class R^2 Difference for Interaction	Student Within Class R^2 Difference for Main Effect
13. Process feedback	.15	.26	.0008	.0049	.14	.10	.0010	.0001
14. Sustaining feedback	.20	.19	.0015	.0000	.20	.22	.0001	.0000
Don't Know and No Response Answers Followed By:								
15. Criticism	.05	.16	.0040	.0055	.05	.04	.0003	.0000
16. Sustaining feedback	.13	.22	.0139	.0000	.12	.10	.0073	.0002
All Response Opportunities Followed By:								
17. Praise	.09	.10	.0011	.0004	.09	.09	.0010	.0004
18. Sustaining feedback	.08	.08	.0017	.0006	.08	.08	.0002	.0001
19 Process feedback	.14	.09	.0037	.0047	.14	.10	.0014	.0038(-)
Academic Contacts:								
20. Student created	.53	.16	.0007	.0000	.53	.20	.0002	.0000
21. Teacher created	.50	.20	.0008	.0000	.50	.23	.0013	.0078(-)
22. That were private	.53	.15	.0000	.0003	.53	.16	.0003	.0007
Misbehaviors:								
23. Nondisruptive	.39	.15	.0000	.0049	.39	.30	.0010	.0016
24. Disruptive	.07	.07	.0077	.0027	.07	.09	.0069	.0043

NOTE: Probability values are indicated by underlining: $p < .05$ where one line appears; $p < .01$ where two lines appear.

Table 3

Average Means and Standard Deviations

for CAT and Achievement Scores

	Mean[1]		Standard Deviation[2]	
	CAT	Achievement	CAT	Achievement
English				
Student-within-class	144.78	158.02	35.84	21.75
Class	144.78	158.02	33.46	19.53
Math				
Student-within-class	135.63	43.74	27.08	15.61
Class	135.63	43.74	24.60	15.65

[1]All means were calculated by averaging class means.

[2]To obtain student-within-class standard deviations, the standard deviations of student scores within each class were averaged across classes. To obtain class level standard deviations, the standard deviation of class means was calculated.